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None

(58) Field of Search
UK CL (Edition N) H4D , H4L
Online: INSPEC, WPI

(54) Coded tag identification and location

(57) An area is divided up into cells, eg 25m square. Each cell has a master station 2 and four slave stations 3. In reply to a suitably encoded low-power interrogation from the master station, transponder tag 4 emits a response. Master station 2 also emits an optical signal to each slave station 3 on optical fibres 5 (which have the same length) at the same time as the interrogation. Each slave station measures the time between reception of the optical and response signals and transmits this to master station 2 via a RS232 datalink 6. Master station sends these times via RS422 link to a central computer 1 which uses a look-up table to determine the position of the transponder 2. Two transponders attached to a body may give its orientation.

Transponder 4 may be solar powered and may contain an EPROM. It may be shut down for 99% of the time, and in a "sleep mode" for the other 1% unless "woken" by the interrogation signal. It may be attached to people, luggage, fire extinguishers, vehicles, or heating, ventilation, air conditioning, communications, surveillance or alarm systems, and may convey sensor readings.

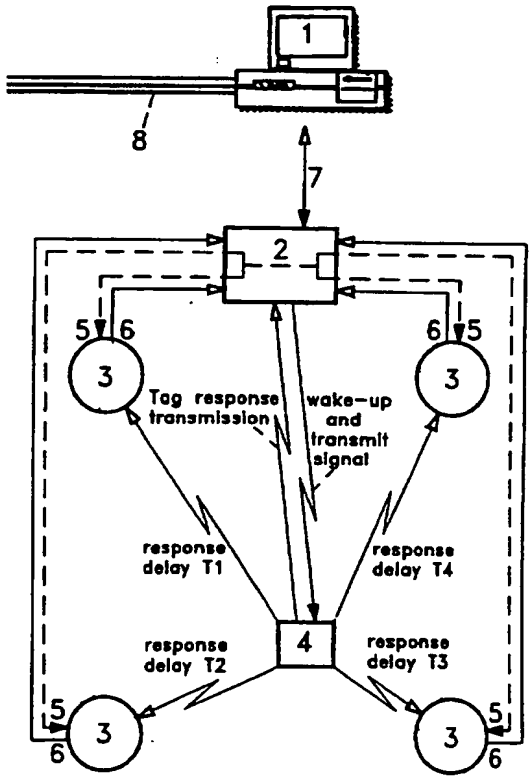

FIGURE 1

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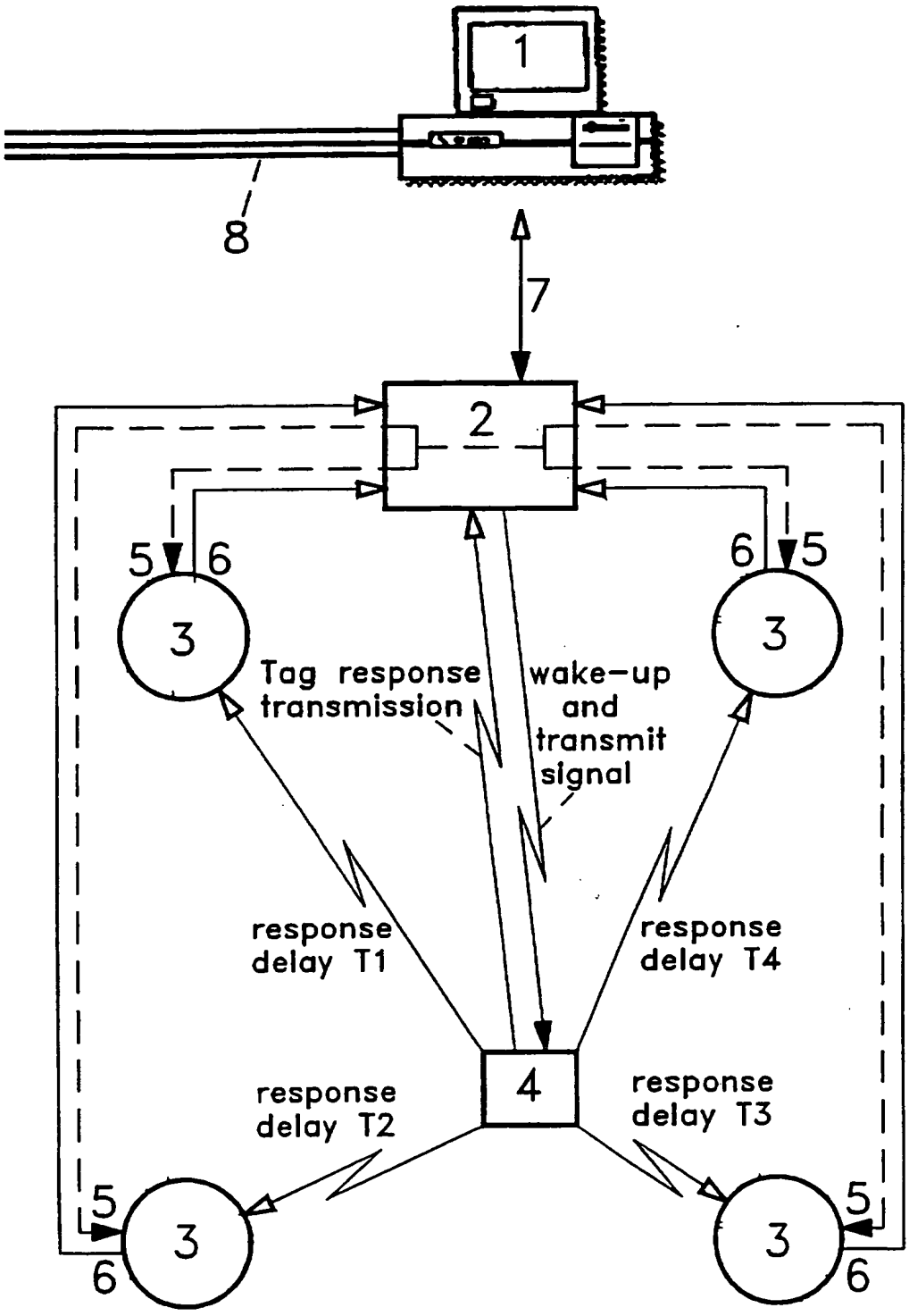

FIGURE 1

INFRA-STRUCTURE FOR LOCATING AND/OR IDENTIFYING CODED TAG DEVICES BY LOW LEVEL POWERED RADIO.

Field of this Invention.

This invention relates to the equipment, devices and apparatus, and an operating method, which comprise an Infra-Structure for providing a means of polling from time to time by low powered radio transmissions a plurality of fixed and movable coded Tag Devices of differing types which will, on command prompts, wake-up and transmit identifying and status data as a series of pulses with a pre-defined time interval enabling a measure of the present positioning of the Tag Devices to be calculated within a tolerance based upon the speed of a Super High Frequency counter relative to a predetermined local Cell Area, or a plurality of such Cell Areas in series, as may be conveniently arranged within the curtilage of a building and/or site, or some part, or parts, of a building and/or site in a single occupation - be they at different levels or not, or simply of an area of land.

The Infra-Structure this invention provides may also be utilised to collect data by radio in the same manner and at the same time, or separately if wished, by polling Tag Devices attached to objects or vehicles and/or controls, sensors, apparatus, items, personnel badges, and other appliances relating to many facilities management and/or mechanical engineering and service functions such as, for example, heating, ventilation, air conditioning, fire alarms, communication systems, and security and surveillance systems; and/or from the databases of the outcome of the positional readings trace the locations, and/or the movements, and/or track changes, if any.

Background to the Invention.

A number and a variety of prior inventions in this field concerning Location, Tracking and Identification Systems within a localised area based on infra-red transmissions are known. U.S. Patent Numbers 4837568 and International Patent WO 93/18476 are examples.

Those Systems utilising infra-red transmissions are constrained by the inability of the transmissions to penetrate through solids as, for example, screens and partitions; positional accuracy is limited to within a localised field area; and when partitioning is resited, or alterations to layouts are made, the system requires extensive physical modification or, on occasion, complete renewal.

Infra-red Systems also need extensive cabling networks to connect units in each and every space; and for additional accuracy a multiplicity of field devices and additional nodes to avoid or circumvent obstruction to signals - all of which would need to be modified and/or renewed whenever material changes are made to room layouts.

Moreover; other low voltage systems for controlling and monitoring the service and environmental facilities usually found in buildings which rely on hardwiring equally require extensive and time consuming modification when anything other than minor alterations are made.

It is a primary object of this invention to avoid these sort of limitations and enable significant operational improvements to be achieved by providing an improved method for more precisely locating and/or interrogating uniquely encoded tag devices by making use of the capacity of radio waves to pass through the partitioning normally found in buildings in a single occupation.

Thereby providing a System that is not constrained to the same extent by the partitioning layout and will more readily accommodate the changes or alterations which often occur to most layouts from time to time without involving significant cost or prolonged delay; that also has the added ability to prioritise poll requests and/or responses at will; is not limited by the capacity of four wire network systems; is sufficiently accurate to be utilised in conjunction with computer aided drafting systems and the related databases; and is more effective generally in terms of initial cost and performance.

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Description of the Invention.

This invention comprises the equipment, devices and apparatus which form a plurality of connected low level powered radio Master and Slave Units arranged either a single Cell, or a series of connected Cells, that is/are also connected to a Computer Facility Host System which forms an Infra-Structure capable of polling and reading data from a plurality of uniquely encoded Tag Devices of different types (which may be attached to fixed or movable items or objects or sensors or apparatus or persons or vehicles or animals or other appliances) for the purpose of determining, for example, their identities, status and/or relative locations.

Based on the effective range of the low level powered radio devices of up to 10 mW operating within a band of up to 500 MHz, a Cell would be say some twenty five metres square in a typical office environment, or a like pre-determined area of various geometric shapes and/or at different levels as may be conveniently arranged within the curtilage of a building or site, or some part or parts of a building or site, or simply a land area of limited extent and normally each Cell will usually have a Master Unit and four Slave Units. However, adjoining Cells may share Master Units and/or Slave Units depending on the geometric configuration of the Cell Areas.

The operational methodology of the invention can be more fully understood when read in conjunction with the schematic layout of a single Cell as illustrated on Figure 1 where:

1. represents the Host System; which comprises any computing facility capable of running the control software:
2. represents the Master Unit; which includes a Transceiver; an optical trigger mechanism; one RS422 port; four RS232 ports; and a low voltage power supply unit:
3. represents Slave Units T1, T2, T3 and T4; each of which includes a Receiver; an optical trigger mechanism; a Super High Frequency Binary Counter; a RS232 communication port; and a low voltage power supply unit:

4a. represents an example of a Tag Device; which includes a low level powered transceiver; a 32 Bit EPROM; a battery(s) and a battery management device:

4b. represents an example of a Solar Tag Device; as described for 4a, but with an added Solar Cell and charging circuit where the polling activities might be more frequent; (such as for a security badge and/or paging system):

4c. represents an example of an Interface Tag Device; as described for either 4a or 4b, but with an added interface capable of communication with other devices; (such as will accept readings from heat sensors or radio fields):

5. represents Fibre Optic Triggering Links; each of the same length with a four splice connection to the Master Unit:
6. represents RS232 Hardwire Links to the Slave Units:
7. represents RS422 Hardware Links to and from the Host System and the Master Units: and
8. represents additional Hardware Links to other Cells.

Referring to Figure 1; all types of Tag Devices 4a, b and c incorporate power management techniques to provide shut-down periods of 990 milli-seconds per second in order to conserve battery power. Otherwise for 10 milli-seconds per second the transceiver resides in a power down sleep mode and is only woken to an operational mode in response to the receipt of a unique code by radio from the Master Unit 2 - which will have been passed a request, or a command prompt, via a RS422 Link 9 from the Host System 1 to poll a particular Tag or Tags.

When any Tag Device 4a, b or c has been woken to an operational mode it transmits a series of radio pulses with a pre-defined time interval and any other data that may be relevant - which the Master Unit 2 receives.

Once the Master Unit 2 of the Cell concerned is satisfied with the Signal Quality, Data and Battery Status of the response transmitted from a particular Tag Device, if any, the Master Unit 2 sends a simultaneous pulse to each Slave Unit 3 via Fibre Optic Links 7 which, on receipt of a suitable pulse edge, triggers the start of the Super High Frequency counters. When the Slave Units 3 receives a second edge from the Tag Device the Super High Frequency counters are inhibited.

The resultant counts in each of the Slave Units T1, T2, T3, and T4 for each individual Tag Device 4a, b or c will be passed via the RS232 Links 8 to the Master Unit 2 as readings which, when requested, are transferred from there via a RS422 Links 9 to the Host System 1.

On receipt of these readings the Host System 1 can store the outcome of each individual Tag Device 4 that has been polled and, by performing calculations where T2-T1 = W, T3-T2 = X, T4-T3 = Y and T1-T4 = Z, can determine and also store for each Tag Device 4 a unique combination of numbers W, X, Y, and Z defining its relative position to a resolution based upon the speed of the Super High Frequency counters within an imaginary grid system superimposed over the Cell Area concerned.

With this method the invention will also allow extension and/or offsetting of the imaginary grid in order accommodate any curved or irregular building forms and/or non-rectangular Cell Area shapes; and provide a method of compensating for slight errors that are anticipated to occur at the edges of the Cell Areas.

Should changes in orientation of any object or item be anticipated which are considered necessary to measure and/or record then these can be identified by the attaching to the object two Tag Devices spaced a suitable distance apart. Alternatively, an Interface type Tag Device can be utilised which incorporates readings either from a Hall Effect device or a Piezo device.

Should any particular Tag Device 4 not be located in the Cell area being polled, the Tag Device will be included in the poll of the next Cell in the series and, if necessary, subsequent Cells. Where it proves a Tag Device cannot be located provision can be made for recording and/or reporting this.

The data thus collected by the Host System 1 can be stored, reported upon and/or applied to a number of different purposes including tracing from the outcome of the positional readings the locations, and/or movements, and/or positional changes, if any, of each of the individual Tag Devices 4 together with the objects, items, vehicles and/or the personnel to which they may be attached.

The Host System 1 would comprise any computer facility capable of executing the control software; and thus have the capacity for each Host System to manage up to, say, 255 Cells. The Host System could also be linked into a Network if desired and receive requests via this from other Host Systems of other installations.

Description of an embodiment of the invention.

A practical embodiment of the invention is the utilisation of location, tracking and identification capabilities within, for example, a building facilities management environment by polling the Tag Devices attached to various objects and/or items via the Infra-Structure of the invention.

Consider a building layout with a floor area of several thousand square metres in which a number of Cells have been arranged utilising, for example, a 2 GHz binary counter in the Slave Units, and where tagged items, devices and sensors in the building have also been delineated as entities/objects (i.e. tables, chairs, desks, outlets, sensors, equipment, etc.,) in the computer aided drawing file of the layout.

The outcome of routinely polling the coded Tag Devices by low level powered radio frequencies of up to 10 mW at 433.92 MHz and reading the data as described before would allow for the Host System to identify, monitor, and track by comparison and/or log the relative movement, if any, of any objects to an accuracy of 0.185 of a metre by radio. This enables the computer aided drawing file and any related and other database to be up-dated without it being essential to inspect the premises physically.

Other coded tagged sensors and control devices related to mechanical engineering and services infra-structure - as, for example, attached to controls and/or sensors and/or apparatus or appliances relating to functions such as heating, ventilation, air conditioning, fire alarms, communication, security and of survelliance systems - can also be routinely polled by radio so avoiding the need for either installing costly hardwired control systems initially or carrying out extensive rewiring exercises when material changes are made to layouts. Something of particular advantage when frequent changes and/or long runs are involved and time is at a premium.

A particular example being for an Interface Tag Device 4c to be attached to all hot water valves and tap outlets so that compliance with future EU regulations can be monitored and maintained with regard to the temperature control of the hot water supply.

Other applications, for example, would be automatic maintainance of inventories - whereabouts of nearest fire extinguishers - luggage monitoring - security access - and fire prevention.

Tracking virtually every movable object within a pre-determined area and its location(s) beyond and/or out of that area can also be achieved by taking the positional readings from the Tag Devices at suitable time intervals dependent on the parameters required.

With this numerous applications of the ability of the invention to locate objects and people become possible including a means and method of tracing and/or tracking and/or identifying and/or positional reading location data at time intervals sufficient to allow the tracking of and recording the movement of individual Tag Devices can be introduced - of which some examples given below are in no way exhaustive.

One such is where service vehicles, containers, pallets, carts, trucks, waggons, barrows and trolleys might be provided with Tag Devices 4a, or Solar Tag Devices 4b, so that they be located and identified and/or their usage tracked; as, for example, the tracking of the pattern of movements taken by supermarket trolleys.

Moreover; the facilities of the invention could be extended to include incorporating Solar Tag Devices 4b into Personnel Badges which can then be tracked - which could also support a low cost pager and messaging system for staff.

Furthermore; the capacity of the system could be substantially increased by various types of Tag Devices each using different radio bands.

The information could also be utilised for automatic control and dynamic re-programming of facilities such as re-directing telephone calls to an extension nearest to the intended recipient, or configuring computers and workstations to current users personal requirements.

Also, physical access to buildings and facilities, and access to computers, can be controlled and the system configured to control the locking and unlocking of doors.

Special Tag and/or Badge Devices to accommodate each one of these functions could then be developed to suit every one of the requirements of individual situations - the data from which could be arranged to be read by radio via the infra-structure of equipment, apparatus and method of operation claimed by the invention described herein.

Then, given the provision of an appropriate Computer Facility Host System and suitable software, a plethora of useful applications of the invention become possible for which the System can be tailored to suit the particular use(s) to which it is to be applied.

The Claims.

1. A System of equipment and apparatus consisting of a plurality of uniquely encoded Tag Devices (which may be attached to items or objects or sensors or apparatus or persons or vehicles or animals or other appliances) and a Master Unit and four Slave Units connected by RS232 links and equal lengths of fibre optic cabling arranged as a Cell - which based on the effective range of the low powered radio devices of up to 10 mW operating at up to 500 MHz could be some twenty five metres square, or a like pre-determined area of various geometric shapes - that is also connected by RS422 links to a Computer Facility Host System; that comprise together an Infra-Structure capable of polling and reading data from differing types of Tag Devices by radio.

2. A System according to claim 1; whereby an encoded Tag Device includes a low powered transceiver; a 32 Bit EPROM; a battery and a battery management device incorporating techniques to provide shut-down periods of 990 milli-second per second to conserve battery power.

3. A system according to claims 1 and 2; whereby the Tag Device transceiver resides in a power down sleep mode for 10 milli-seconds per second and is only woken to an operational mode in response to the receipt of a unique code by radio polling from the Master Unit acting on a command prompt from the Host System.

4. A system according to claims 1 to 3; whereby a Solar Tag Device type includes an added Solar Cell and charging circuit.

5. A system according to claims 1 to 4; whereby an Interface Tag Device type includes an added interface capable of communication with other devices.

6. A System according to claim 1 and 5; whereby the Master Unit includes a Transceiver; an optical trigger mechanism; one RS422 port; four RS232 ports; and a low voltage power supply unit: and the Slave Units T1, T2, T3 and T4 include a Receiver; an optical trigger mechanism; a Super High Frequency Binary Counter; a RS232 communication port; and a low voltage power supply unit.

7. A System according to claim 1 to 6; wherein the data transmitted from the Tag Devices by radio includes a series of pulses with a pre-defined time interval which the Master Unit receives and - being satisfied with the Signal Quality, the Battery Status and the Data - sends a simultaneous pulse via Fibre Optic Links to each Slave Receiver Unit to trigger the start of Super High Frequency counters that are, in turn, inhibited on receipt of a second edge from a unique Tag Device resulting in counter readings T1, T2, T3 and T4 which are transferred via RS323 Links to the Master Unit.

8. A System according to Claims 1 to 7; wherein the counter readings - together with any other data and readings from the relevant Tag Device - are, on a request or command prompt, then transferred from the Master Unit via RS422 links to the Host

System and stored enabling a measure of the present positioning of the individual Tag Devices to be calculated from the said set of counter readings to within a tolerance based upon the speed of a Super High Frequency counters relative to an imaginary grid system superimposed on the Cell Area.

9. A System according to claims 1 and 8; wherein, by performing calculations where T2-T1= W, T3-T2= X, T4-T3= Y and T1-T4= Z for each individual Tag Device, a unique combination of numbers W, X, Y, and Z defining its present relative position to a resolution based upon the speed of the Super High Frequency counters within an imaginary grid system superimposed on the Cell Area concerned can be determined by the Host System and stored.

10. A System according to claims 1 to 9; which provides a method of compensating for slight errors that are anticipated to occur at the edges of the Cell Areas.

11. A System according to claims 1 to 10; which also allows for the extension and/or offsetting of the imaginary grid in order accommodate any curved or irregular building forms and/or non-rectangular Cell Area shapes.

12. A System according to claims 1 to 11; whereby a means of measuring any changes in the orientation of any object or item either by the attaching to the object or item two Tag Devices spaced a distance apart.

13. A System according to claims 1 to 11; whereby a means of measuring any changes in orientation of any object or item is by an Interface Tag Device which incorporates either Hall Effect devices or a Piezo device.

14. A system according to any of the claims 1 to 13; whereby the capacity and/or scope of the system is increased by utilising different radio bands and added transceivers in tandem.

15. A system according to claims 1 to 14; which provides a means and method of tracing and/or tracking and/or identifying and/or reading data at intervals from Interface Tag Devices relating to mechanical engineering and services infra-structure as, for example, attached to controls and/or sensors and/or apparatus relating to functions such as heating, ventilation, fire alarms, air conditioning, communication and survelliance systems.

16. A system according to claims 1 to 15; by which other applications could be, for example, the automatic maintenance of inventories - the whereabouts of nearest fire extinguishers - luggage monitoring - controlling security access - the monitoring of fire prevention related alarms - and communication systems.

17. A System according to claim 1 to 16; which provides a means and method of tracing and/or tracking and/or identifying and/or reading location data at sufficient accuracy to apply the outcome to the computer database(s).

18. A System according to claim 1 to 17; which provides a means and method of tracing and/or tracking and/or identifying and/or reading location data at sufficient accuracy to apply the outcome to the updating of computer aided layout drawing files and their related databases.

19. A system according to claims 1 to 18; which provides a means and method of tracing and/or tracking and/or identifying and/or positional reading location data at time intervals sufficient to allow the tracking of and/or recording the movement(s) of the individual Tag Devices.

20. A system according to claims 1 to 19; whereby Tag Devices are incorporated into Personnel Badges which can then be tracked.

21. A System according to claims 1 and 20; whereby a low cost pager and messaging system for staff could be supported.

22. A System according to claims 1 to 20; whereby location information can be utilised for automatic control and dynamic programming of facilities such as re-directing telephone calls to an extension nearest to the intended recipient, or to configure computers or workstations to current users personal requirements.

23. A System according to claims 1 to 20; whereby physical access to buildings and facilities, and access to computers, can be controlled and where the system could also be configured to control the locking and unlocking of doors.

24. A System according to claims 1 to 20; whereby service vehicles, containers, pallets, carts, trucks, waggons, barrows and trolleys may be provided with Tag Devices so that they may be located and identified and/or their usage tracked; as, for example, the paths taken by supermarket trolleys.

25. A System according to any of the claims 1 to 24; whereby the Master Unit is connected via RS422 links to a Host System comprising any computing facility capable of executing the control software.

26. A System according to any of the claims 1 to 25; whereby the Host System of the invention is interlinked with a Network and can receive requests via this from other Host Systems of other installations.

27. A system according to any of the claims 1 to 26; whereby it is arranged that there are a plurality of such Cells in series - which (based on the effective range of the low powered radio devices) will, for example, each range up to say twenty-five metres square or a series of like pre-determined areas of various geometric shapes and/or at different levels as conveniently arranged within the curtilage of a building or site, or some part or parts of a building or site, and/or a land area of limited extent - where each Cell will have a Master Unit and four Slave Units.

28. A System according to claim 27; whereby adjoining Cells may share Master Units and/or Slave Units depending on the specific geometric configuration of the Cell Areas.

29. A System according to any of the claims 27 and/or 28; wherein data readings are obtained from each and every responsive Tag Device from every Cell Area and the immediate adjoining areas in series by the same methods described in claims 1 to 27 and, on request, transferred from the Master Units via RS422 links to the Host System.

30. A system according to claims 26 to 29; whereby the Host System would comprise any computer facility capable of executing the control software and have the capacity to manage up to, say, 255 Cells per Host.

31. A system according to claims 26 to 30; whereby the Host System of the invention is inter-linked with a Network and can receive requests via this from other Host Systems of other installations.

32. An Infra-Structure for Locating and/or Identifying Coded Tag Devices by Low Level Powered Radio substantially as here-in-before described with reference to the accompanying schematic layout of a single Cell as illustrated on Figure 1 as appended.

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Examiner's report to the Comptroller under Section 17
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Search Examiner
DR E PLUMMER

Date of completion of Search
21 MARCH 1995

Databases (see below)
(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii) ONLINE: INSPEC, WPI

Documents considered relevant following a search in respect of Claims :-
ALL

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages	Relevant to claim(s)
	NONE	

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